

Other successes with forms of rest-rotation in allotments with riparian areas have been reported:

- On several allotments in the Tonto National Forest in Arizona, rest-rotation systems, together with proper stocking and other management, resulted in cottonwood and willow regeneration along perennial streams. These systems incorporated high-intensity, short-duration grazing, with each pasture receiving spring-summer rest for 2 years out of 3. In 1978, the Sedow Allotment (34,800 acres) on the Globe Ranger District was placed under this system after the permitted 11,125 AUMs were reduced to 5,800 AUMs. When the system was initiated, the Walnut Spring area of the Storm Canyon pasture did not have cottonwood or willow between 0.1 and 10.2 cm (0.4 to 4 inches) in diameter. By 1982, the area supported 650 cottonwoods and 2,275 willows per hectare (263 and 920 per acre, respectively) in this size class (Davis 1982). The Superior Allotment is another that has responded positively to this same grazing system (Flanigan pers. comm.).
- On the Humboldt National Forest in north-central Nevada, a three-pasture, rest-rotation system in effect for 12 years has improved areas of degraded riparian habitat. The Wilson Creek Pasture Allotment is comprised of mixed sagebrush-grassland, with scattered stands of aspen and smaller quantities of fir and spruce. The grazing system provides for rest following seedripeness on the upland key species (Idaho fescue) in the first year, followed by rest from turnout (July 1) to seedripeness in the second year, and season-long rest in the last year of the cycle. This management has resulted in aspen and willow rejuvenation, streambank stabilization, and recovery of some of the former fishery (Easton pers. comm.). Although no utilization was sampled in the riparian area, utilization in the uplands was in the 35-40 percent range in 1985.
- Cooperation from permittees and the U.S. Forest Service, frequent use supervision, and a rest-rotation strategy have maintained and improved riparian habitat in the White Acorn Allotment of the Green River Resource Area of the Rock Springs District. This sagebrush grassland allotment with riparian areas and wet and dry meadows was formerly grazed by sheep, but is now grazed by 800 cattle (Kroosting and Christensen pers. comm.). Three pastures are managed under a deferred rotation system, while three other pastures are grazed under a rest-rotation system. Concern with riparian habitat is focused primarily in the three pastures on Blucher Creek. Prior to the change in management (1981), plant vigor was low, bank trampling damage was apparent, willows were the size of garbage cans, and wildlife habitat was in poor condition (Smith pers. comm.). The allotment management plan required herding for maintaining even distribution and control of livestock in each pasture. Riparian values are being maintained and improved under this management strategy. Most streambanks are stable, willow of all age classes are present, plant vigor is good, and the wildlife habitat is much improved.

### ***10. Holistic Resource Management***

Holistic Resource Management (HRM) was developed by Allan Savory. HRM, with its associated grazing and other practices, does not specify any set strategy. However, most HRM applications use "time-control grazing" to concentrate animal

impacts in time and space, thereby avoiding regrazing before recovery and overresting plants adapted to herbivory. Time-control grazing is like high-intensity, short-duration grazing except that the rate of rotation varies with the rate of plant growth. Depending on how well it is planned and implemented, it can be good for riparian management. Because it specifies that management should focus on objectives and uses many pastures, there is limited opportunity for livestock distribution problems. At any time, a pasture can be skipped if site-specific management needs warrant it.

HRM has been used to improve general range conditions and riparian conditions on the Desert Land and Livestock Company ranch in north-central Utah. Prior to implementation of HRM, much of the rangeland on the ranch was in a deteriorated condition (Secrist pers. comm.). Many sagebrush-filled gullies were present in the lower elevations. Muddy water flowed in the drainages during snowmelt or following heavy rains. Riparian herbaceous vegetation was absent in most drainages including Saleratus, Negro Dan, Stacy Hollow, and others, and no willows could be found.

An HRM program was initiated on the ranch in 1979, with the objective of making a profit while improving the health of the range. Since grazing animals were originally part of the ecosystem, livestock were chosen as the tool for accomplishing this objective. Cattle, sheep, and buffalo are managed to control the timing and duration of grazing, as well as animal impact.

Flexibility in time control has been achieved by grouping animals into large herds (from 1,300 yearling heifers to 3,500 pairs and 6,000 yearling steers) and creating more pastures through fencing. Three cattle herds and six bands of sheep use 100 different pastures on the ranch. Depending on range conditions, vegetation, and economic goals, pastures are used one to three times per year; the majority are only used once. Stock density (animals per acre) has ranged from 0.5 to 3.5, depending on pasture size. Time in each pasture is determined by how fast plant growth is occurring. When growth is rapid, pasture moves are frequent. When growth is slow, the livestock stay longer in each pasture. When plants are dormant, lack of forage and animal performance determine when livestock are moved. Time in each pasture has ranged from 3 days (during rapid growth) to 100 days (during dormancy). During the growing season, the grazing animals are moved from pasture to pasture in an attempt to graze each plant severely only once, and then allow it to recover from the effects of defoliation before it is grazed again. Yearling cattle and sheep are moved by herding. The 3,500 pairs are trained to move from pasture to pasture by responding to a whistle.

Herd effects result in animal impact: 1) hooves break up (physical) soil crusts, enrich soil, and provide cover by incorporating manure, litter, and seeds into the soil surface, 2) urine adds urea to the soil, 3) hoofprints create seedbeds and pockets for collection of litter and precipitation where seeds are pressed into contact with mineral soil, and 4) grazing, trampling, crushing, etc., prunes plants to stimulate new plant growth. Animal impact, when properly managed, is very important to the health of these rangelands. The herd effects, particularly the hoofprint seedbeds, improve microsite conditions for the germination of seeds and establishment of seedlings, which can be the weakest link in the natural function of many range ecosystems.

New plants result in additional pathways for water to get into the soil reservoir where it is stored, purified, and slowly released into riparian areas. (Note: The physical effects described above can be detrimental in areas where microbiotic crusts are an important component and/or on soils with vesicular crusts.)

The ranch manager believes that this method of grazing results in an increase in ground cover, water infiltration, and soil moisture, and restores some of the natural hydrologic function to the watershed. Riparian vegetation has reestablished in the drainages, serving as a sediment trap that raises the water table. As this healing process continues, the bottom of the drainage rises in elevation, thus deepening and widening the riparian aquifer. As a result, riparian vegetation expands into the edges of the uplands and floods sagebrush. Clear water flows year-round and willows have established themselves where they did not exist before. The streambed in one drainage has increased more than 6 inches in elevation. Gully banks are slumping and are being vegetated by riparian plants. Sagebrush is dying as the riparian areas expand. Though precipitation and runoff were far above normal, the additional ground cover in the uplands and the improvement in the riparian habitat prevented significant erosion damage on the ranch in spite of increased stocking rates (Table 7) (Simonds pers. comm.).

**Table 7.** Stocking levels on the Desert Land and Livestock Company ranch.

	1979	1986
Cattle	4,500	10,460
Sheep	12,000	10,000 (approximate)
Elk	350	1,500
Buffalo	0	230

### ***11. Total Rest***

Depending on the riparian area objectives, tools and finances available, and time prescribed for reaching objectives, nonuse may be the best alternative for realizing the most rapid improvement. A deteriorated riparian area with few trees or shrubs, or one where the objective is to get woody plant regeneration above the reach of livestock, may require total rest, at least for a few years (Davis 1982).

Exclusion of livestock has produced improved riparian and aquatic habitat following 4 to 7 years of total nonuse, woody plant (shrub) recovery following 5 to 8 years of total rest, a doubling of fish biomass following 3 to 5 years of total rest, and attendant positive responses in birds and small mammals (Skovlin 1984). A study on Big Creek in northeast Utah concluded that a minimum of 6 to 8 years of nonuse was necessary to restore a deteriorated streamside riparian area to the point where livestock grazing could be allowed at reduced levels (Duff 1983). However, substantial recovery of streambanks and vegetation was observed following 4 years of exclusion of grazing by fencing.

### **C. Techniques that Attract Livestock Away from Riparian Areas**

- Water development in upland areas that lack water is often a key factor in reducing livestock concentrations in riparian areas. Where feasible, water development can be achieved by installing solar, hydraulic ram, or conventional pumps; developing springs, seeps, wells, or guzzlers; and piping water to several troughs once collected. Even within riparian areas or riparian pastures, water developments, ponds, or troughs can reduce streambank trampling damage. However, they tend to concentrate disturbance rather than distribute it. Any water development should avoid creating new problems, such as excess soil erosion or vegetation/habitat impacts. Creating shade and locating rubbing posts and oilers nearby may augment water development and help reduce the time livestock spend in riparian areas.
- Planting palatable forage species on depleted upland areas can attract livestock away from riparian areas.
- Prescribed burning often enhances forage production, palatability, and upland use. In fact, the attraction often forces temporary rest until vegetation recovers.
- Placing salt, hay, grain, molasses, and other supplements only in upland areas away from riparian areas improves distribution. Except where salt and supplements are used to intentionally localize animal impacts, they should generally be placed no closer than 1/4 mile, and preferably 1/2 mile or more, from riparian areas and intermittent drainages (Riparian Habitat Committee 1982). Proper salting improves both distribution and utilization. At least one livestock operator relates that sawing salt blocks in half allows frequent movement of salt stations to minimize localized impacts of concentrated use.

Supplements can affect forage preference and selectivity. Energy supplements can increase browse utilization (although it may also depress utilization of fiber). High-protein supplements, such as cottonseed or soybean meals or cake, balance diets and increase consumption of cured grass that is protein-deficient. However, there is anecdotal evidence that supplements such as cottonseed meal were also used extensively to get livestock to rid pastures of "unwanted" willows.

- Residual vegetation from previous years decreases forage palatability and quality and diverts grazing from new areas. Use patterns perpetuate themselves, and thus, when carefully planned, periodic forced intense use of pastures (e.g., by dry cows in an off season), can reduce "wolf plant" problems, improve distribution, and increase forage quantity and quality.

### **D. Techniques that Exclude or Promote Avoidance of Riparian Areas**

- When properly located, well-constructed, and maintained, fencing can be an effective tool for controlling distribution. Fencing facilitates management of riparian areas by either including or excluding livestock use, depending on

management objectives. Sometimes exclusion fencing can be the most practical approach for initiating rapid riparian recovery or improving highly sensitive areas, or it can be a temporary measure for initiating recovery. The loss of forage from exclusion fencing may be inconsequential in many allotments. On 365 miles of Oregon streams, riparian areas comprise only 3.5 acres, 7 AUMs, or 100 cows for 2 days per mile (Elmore pers. comm.). Fencing water sources at springs and seeps and piping the water to adjacent areas is often the only effective measure for protecting small riparian areas. However, fencing may restrict wildlife and livestock movements in an undesirable manner. In addition, fence construction and maintenance can be costly and time-consuming.

- Barriers formed by placing trees and brush on streambanks may discourage livestock use and help stabilize eroding banks. Placing boulders (10 to 20 inches or larger) along streambanks where livestock trail and cause trampling damage can effectively displace livestock use and promote recovery (Myers pers. comm.).
- Hardened crossings and water access points are gravel pads that provide livestock sure footing on a gentle grade to water, either for crossing a stream or for drinking. Livestock prefer gravel pads over trying to negotiate steep, overhanging streambanks. During a roundup, cows will run for the gravel pad before trying to cross the stream (Massman ed. 1995).
- Frequent riding and herding can effectively control livestock distribution in some situations. On some rough or poorly watered ranges, proper herding may increase breeding, conception, and calf crops (Stoddart et al. 1975). Several of the successful strategies reported by Massman (1995) and Masters et al. (1996a and 1996b) also incorporate riding and herding into overall management.
- Bed grounds and other livestock handling facilities should be located away from riparian areas (Riparian Habitat Committee 1982).
- Locating livestock turnouts far away from overused riparian areas may help regulate the timing, duration, and amount of riparian use in large pastures that contain adequate stock water (Gillen et al. 1985).
- Gap fencing in conjunction with gullies, cliffs, and other natural barriers can regulate natural trailing or loafing by livestock in some riparian areas.
- Locating water gaps in rocky areas (natural or manmade) minimizes trampling damage to streambanks and streambeds. Narrow water gaps discourage livestock from loafing at the water source.

#### **E. Herd Management and Animal Husbandry Practices**

- Culling practices are traditionally aimed at improving animal performance in conception rates, weaning weights, conformation, etc. However, some operators also cull on habitat use tendencies and foraging characteristics. Roath (1980)

and Bailey et al. (1996) indicate that within breeds, or even herds, certain individuals tend to spend more time in the bottoms while others tend to forage widely. George (in press) found that culling could rid herds of individuals that spend disproportionate time in the bottoms. The permittee on the Bruneau Allotment in Nevada culled "riparian loafers" and stated that this practice led to a more robust herd of mother cows that remained on hillslopes more and produced larger calf crops with higher weaning weights.

- Unrestricted use by cow-calf pairs generally impacts riparian areas more than use by other kinds/classes of livestock. They tend to concentrate, loaf, and forage in bottoms. Yearling cattle, particularly steers, generally tend to be wider ranging and use more of the adjacent uplands.
- Changing the kind of livestock adjusts both the distribution pattern and forage preference. Herded sheep offer several options for achieving proper management in certain riparian areas. Sheep use may be more desirable than cattle use in some areas due to the herders' control over location, timing, degree, duration, and frequency of use. Sheep prefer hillsides to the confining nature of riparian bottoms. If not bedded in a riparian area meadow, the herder can easily move them to uplands or ridge tops. Generally, herders want to keep flocks or bands moving so as to facilitate forage selectivity. The quality of herding controls riparian effects and the rate of gain (Glimp and Swanson 1994). Sheep may do less physical damage to herbaceous plants due to their nibbling characteristics, whereas cattle and horses can dislodge plants from the soil because they graze with a pulling motion. When properly herded, sheep cause less trampling damage than cattle (Stoddart et al. 1975).

Sheep under unherded conditions have been observed to consume spring willow growth in Oregon when adequate herbaceous forage was available (Elmore, pers. comm.). Heavy browsing of young willow growth by unherded sheep was observed in southern Wyoming during spring, summer, and fall where the herbaceous vegetation was dominated by coarse forage such as sedges and rushes.

Horse use during the winter in some areas may result in bark being stripped from deciduous trees (Kindschy pers. comm.). However, horses are primarily regarded as grass eaters, and they generally congregate less than cattle (Stoddart et al. 1975). The concentration of wild horses on riparian meadows has been reported to result in severe riparian impacts (Platts pers. comm.). Concentrated spring or seep use causes problems in other areas.

- Most livestock operators would not consider a change in breed of livestock simply to improve distribution. However, breed habits might become a consideration if an operator is considering a change for other reasons. Higher heat tolerance (and related foraging characteristics) of Brahman, Brahman crosses, and other zebu types is often a consideration in southern and southwestern states, for example. Extension livestock specialists are a good source of information about animal characteristics and habits.

## VI. Monitoring

No discussion of grazing management would be complete without considering monitoring. Once objectives have been established and a grazing strategy selected and implemented to achieve those objectives, the only way to evaluate success or failure is through monitoring. Monitoring should include both short-term and long-term strategies. Short-term monitoring includes annual documentation of implementation activities, events, and interpretive measurements or observations of effects that influence progress toward objectives. Long-term monitoring documents and measures trends toward or achievement of objectives, usually over a period of years.

Many agency, interagency, and extension references guide planning, method selection, and analysis and interpretation of monitoring data. A few examples are presented below (full citations are presented in the References section):

- Rangeland Monitoring - Planning For Monitoring (USDI 1984) and others in the BLM TR 4400 series
- Methods for Evaluating Riparian Habitats With Applications to Management (Platts et al. 1987)
- Inventory and Monitoring of Riparian Areas (Myers 1989b)
- Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams (Bauer and Burton 1993)
- Herbaceous Stubble Height as a Warning of Impending Cattle Grazing Damage to Riparian Areas (Hall and Bryant 1995)
- Rangeland Analysis and Management Training Guide (USDA 1996) and other USFS regional guides
- Sampling Vegetation Attributes (Interagency Technical Team 1996a)
- Utilization Studies and Residual Measurements (Interagency Technical Team 1996b)

It would not be feasible to summarize the measurement techniques in these references or even list all of the applicable references, but there are a few points worth emphasizing.

### A. General

All stated management objectives require some strategy for monitoring their accomplishment. Likewise all monitoring should tie directly to the analysis of and accomplishment of specified objectives. This may seem obvious, but in an analysis of 20 grazing allotments in northeastern California and northwestern Nevada, Olson (1989) found that not one combined all the elements of a systematic process by

linking goals, issues, and objectives with action, monitoring, and evaluation. Olson states, "Management objectives, overall, were not measurable or realistic, providing no solid vegetative benchmarks for determining management successes. In the cases where management objectives were both measurable and obtainable, the supporting monitoring studies and evaluations were incomplete." Subsequent program reviews have identified similar problems in virtually every location to one degree or another. Monitoring that has no direct relationship to objectives is another frequent problem that increases costs and usually detracts from necessary monitoring and administrative tasks.

## **B. Short-Term Monitoring**

### ***1. Implementation***

The best strategy will surely fail if it is not followed. Therefore, implementation or "compliance" monitoring is essential. Implementation monitoring is simply ensuring that livestock are in the right place, at the right time, in the right numbers, and that any additional measures to improve distribution are being taken. Without tracking what was done and where which animals were when, managers will not understand why strategies worked or failed.

Compliance with a grazing system is critical. When stock are moved from a management pasture, it is commonplace for a few animals to be overlooked. If a few undetected livestock drift back or reenter a grazed pasture through faulty fences or ineffective natural barriers, they can quickly "undo" any progress that deferment or rest might have accomplished. It only takes a few weeks of unauthorized use or overgrazing to set back years of progress in improving riparian systems (Duff 1983). In one stream, annual use by a few head of unauthorized livestock throughout most of the hot season period has nullified positive riparian habitat responses in an otherwise excellent grazing system (Myers 1981).

### ***2. Seasonal, Annual, and Cyclic Events***

Long-term monitoring studies or use maps require documentation of seasonal, annual, and cyclic events such as fire, insect infestations, disease, weather, and associated hydrologic phenomena. Such effects must be distinguished from the effects of grazing for evaluation. The effects of weather-associated phenomenon are often less distinct. Floods and droughts can have both beneficial and detrimental effects on riparian plant communities, as well as on channel characteristics.

Floods may widen channels and increase width/depth ratios, which is generally not beneficial. However, floods may also redistribute sediments to floodplains, recharge shallow aquifers, and initiate recruitment of many plants (especially willows and cottonwoods) depending on timing, discharge, channel shape, and floodplain access. Key points to be considered are: 1) whether or not livestock grazing or bank disturbance before or after a flood led to additional widening, and 2) whether the grazing strategy allowed for establishment of plant species dependent on floods for recruitment.

Droughts increase moisture stress on plants and plant communities, which tends to concentrate livestock and wildlife in riparian areas even more than normal. They also tempt the use of pastures slated for rest. However, low flows associated with droughts reduce the stress on banks, and there is usually enough water in channels to continue to support hydric, bank-forming vegetation. Given the chance, most perennial vegetation helps channel narrowing and bank building with fine sediments transported after reduced flows. Key points to be considered are: 1) whether or not the timing, intensity, and duration of grazing during the drought allowed for plant colonization and stabilization of exposed banks or wide channel edges, and 2) whether the grazing strategy leaves enough residual vegetation (or regrowth) to trap and retain fine sediments for bank building.

### ***3. Utilization and Stubble Height***

Measurements of utilization and stubble height (residual vegetation) help interpret whether or not long-term objectives were met. Utilization or stubble height can be monitored annually or more frequently, and can guide stock movement decisions where needed or appropriate. However, measuring progress toward long-term resource objectives, such as bank stabilization, rebuilding of the streamside aquifer, or reestablishment of beaver, fish, or moose habitat, requires years of intervening management. Herbaceous stubble height is usually easier to document. It is easier to measure what is there than what is gone. Stubble height can be an excellent tool for warning of impending damage to riparian areas (Hall and Bryant 1995).

Timing of utilization of key species with respect to plant phenology often affects subsequent growth and reproduction more than amount of utilization. Therefore utilization mapping relative to plant growth and community distribution can provide more insight to the appropriateness of a particular grazing strategy than utilization of a key area alone. Utilization maps also describe the pattern of livestock use relative to topography, vegetation, water, salt, season, and all other management factors. It therefore can guide adjustments better than most other forms of monitoring information. However, accuracy and precision limitations of utilization measurements should be recognized in all interpretations. There is often high sampling variability among sites and among observers, especially for shrubs. Because of these limitations, high confidence levels require intensive sampling and more time and money. In addition, relative utilization (utilization determined at any time other than peak standing crop) has little relationship with utilization at peak standing crop for determining plant or community response to defoliation. Therefore, interpretations should be made with caution!

In spite of the potential limitations and for lack of a better tool, many managers have had to establish utilization guidelines for short-term management considerations. To establish utilization guidelines, the manager should know and consider the growth habits and characteristics of the important plant species; how they respond to grazing and browsing; and the characteristics, preferences, and requirements of the grazing-browsing animals. Utilization guidelines, where used for riparian areas and riparian pastures, should:

- Maintain both herbaceous and woody species (where present) in a healthy and vigorous condition and facilitate their ability to reproduce and maintain different age classes in the desired riparian plant community.
- Leave sufficient plant residue to protect banks, filter sediment, and dissipate flood energy during runoff events.
- Maintain consistency with other resource values and objectives; e.g., esthetics, water quality, etc.
- Limit streambank shearing and trampling to acceptable levels. (However, bank trampling guidelines should be set separately for stream reaches where this is important.)

In some cases, setting proper utilization guidelines requires trial and error through monitoring, analysis, and evaluation of the results after adjusting management. Because initial results may vary from expectations, the manager should not hesitate to change key species or utilization guidelines to meet objectives.

### **C. Long-Term Monitoring**

If the relationships between objectives and monitoring are maintained, the establishment of long-term trend studies is well underway. Because of the central role and inherent variety in appropriate management objectives, useful and appropriate measurement/monitoring techniques vary widely. No short list could be complete, and each technique requires a detailed description to guide its proper application.

However, there is one aspect of long-term vegetation monitoring in riparian areas that is significantly different than monitoring in uplands and often leads to confusing interpretations. Riparian ecological sites or plant communities can move as streams move and change their distribution and extent over time (Gebhardt et al. 1990) (Winward and Padgett 1986) with changing water tables, etc. Many objectives tied to kind, proportion, or amount of vegetation are best monitored by methods that account for changes along the stream edge (green line) or throughout the riparian complex. The Integrated Riparian Evaluation Guide (USDA 1992) and others describe methods to account for these phenomena rather than rely on a fixed point or plot as is common for upland sites.

## **VII. Learning from Experience**

Grazing prescriptions and associated management of riparian areas should be monitored, evaluated, and reconsidered regularly. Managers should not hesitate to identify problems and make changes in grazing treatments, and to take risks and try new alternatives to achieve objectives. But along with this, it is important that the conditions under which each system does and does not work be documented.

Existing documentation of successful grazing management in riparian areas is only marginal. Documentation of successes, as well as of failures, is essential for learning from past efforts. Any riparian monitoring plan should mandate before and after photos, with backup data, to show the effects of management. Documenting pre-treatment resource conditions provides a basis for interpreting results and avoiding past mistakes, and provides a “springboard” for exploration of other options. Successes and lessons learned should be shared through presentations at meetings of professional societies, the livestock community, conservation groups, and agency workgroups, and in professional and popular publications.

## **VIII. Cardinal Rules for Planning and Managing Grazing in Riparian Areas**

- Adapt grazing management to the conditions, problems, potential, objectives, public concerns, and livestock management considerations on a site-specific basis.
- Manage grazing to grow and leave sufficient vegetation stubble on the banks and overflow zones to permit the stream to function naturally.
- Identify and implement alternatives to passive, continuous grazing.
- Take advantage of seasonal livestock preference for uplands in grazing prescriptions.
- Employ rest from livestock grazing whenever appropriate.
- Consider the whole watershed and all important resource issues.
- Include all those willing to learn the details and contribute ideas or work for better management, including the livestock user and other interests. Everyone involved should understand and agree on the problems and objectives, as well as understand the changes that can occur and how they can benefit from proper management and improved riparian conditions.
- Involve the livestock user in designing the grazing system and monitoring the results.
- Build flexibility into grazing management to accommodate changes based on need.
- Implement frequent (sometimes daily) use supervision by the parties involved once management is in progress so that adverse impacts (e.g., trampling damage and excessive utilization) can be foreseen and avoided.
- Document mistakes so they are not repeated.
- Use management successes to promote good riparian area management elsewhere.